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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/662,522	09/16/2003	Anthony Dip	241482US6YA	1707
22850 7590 02/07/2007 OBLON, SPIVAK, MCCLELLAND, MAIER & NEUSTADT, P.C. 1940 DUKE STREET ALEXANDRIA, VA 22314			EXAMINER STOUFFER, KELLY M	
			ART UNIT	PAPER NUMBER
			1762	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	02/07/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary

Application No.

10/662,522

Applicant(s)

DIP ET AL.

Examiner

Kelly Stouffer

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 21 December 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,4-13,20-26,29-38,52,55,56,59-62,65 and 78-82 is/are pending in the application.
- 4a) Of the above claim(s) 55,56 and 65 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,4-13,20-26,29-38,52,59-62, and 78-82 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- ☐ Notice of Informal Patent Application
- ☐ Other: _____

DETAILED ACTION

Response to Arguments

Applicant's arguments, filed 21 December 2006, with respect to the 35 USC 112 2nd paragraph rejection of claim 78 have been fully considered and are persuasive. The 35 USC 112 2nd paragraph rejection of claim 78 has been withdrawn.

Applicant's arguments, filed 21 December 2006, with respect to the 35 USC 112 1st paragraph rejection of claims 81 and 82 have been fully considered but they are not persuasive. The applicant argues that adequate support for the limitation in claims 81 and 82 that requires substrates to be present on the middle to lower surface of a tier holder, specifically the bottom 50 spaces of the tier holder. Though the amended claims now recite a reason why one of ordinary skill in the art would want to place substrates in a specific position in the substrate holder, Figures 10 and 11 describe thickness and film uniformity as functions of gas exposure time and numbers of gas flow cycles, not as a function of tier position. The original disclosure still does not provide support for only placing substrates in a specific position in the tier holder, nor does it provide support that placing the substrates in a specific position will form the desired film properties. Therefore, the 35 USC 112 1st paragraph rejection of claims 81 and 82 are maintained and are repeated here.

Applicant's arguments, filed 21 December 2006, with respect to the 35 USC 103(a) rejections of claims 1, 79, and 81 have been fully considered but they are not persuasive. The applicant argues that the data in Figures 10, 11, and 13 show criticality

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for the claimed substrate temperature, flow rates, and flow cycles and their importance in the invention is to improve uniformity of processing among the plurality of substrates, as is recited in the amended claims. Though Figures 10, 11, and 13 provide data correlating the uniformity of the film among the plurality of substrates to substrate temperature, flow rates, and flow cycles, the Figures and the specification fail to disclose that one of ordinary skill in the art would want to use these substrate temperatures, flow rates, and flow cycles to form a film commensurate in scope with the claims. The claims containing these variables include a hafnium oxide film made with any type of precursor, any type of substrate, and other broadly cited process conditions (ie. chamber pressure, etc.). The data given in Figures 10, 11, and 13 show that the temperature and flow rates give a different result when using a specific precursor, a specific substrate, and specific reaction conditions. Therefore, the data are not sufficient to show that the claimed variables are critical and receive the same result for the entire scope of the claims. The variables are thus not deemed critical for all that the claim encompasses given the evidence cited by the applicant. In addition, the cited prior art in the previous office action indicate that these variables are dependant upon the apparatus and conditions used in carrying out the invention (Doan et al. paragraph 0022 et seq.) and use various substrate temperatures, flow rates, and flow cycles in order to receive a certain layer quality during the ALD process, which would include film uniformity among a plurality of substrates (Doan et al. paragraphs 0005 and 0022 et seq., Chang et al. paragraph 0041, Maes column 4 lines 41-53, Pange et al. column 8

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lines 8-37). Therefore the 35 USC 103(a) rejection of the claims is maintained and is repeated here.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 81 and 82 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. In claims 81 and 82, the applicant requires substrates to be present on the middle surface to lower surface of a tier holder, and more specifically the bottom 50 spaces of the tier holder. While the applicant provides for a tier holder with a designated top, middle, and bottom, the original disclosure does not indicate only placing substrates on the middle or bottom, or does not include any information about the bottom 50 spaces of the tier holder or placing slides exclusively in the bottom 50 spaces.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148

USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1, 4-7, 11-13, 20-21, 23, 31-33 and 52 are rejected under 35 U.S.C.

103(a) as being unpatentable over US Patent publication 2003/0176060 to Doan et al.

Doan et al. includes a method of forming HfO_2 on a semiconductor substrate (abstract lines 1-2) by ALD, flowing a pulse of Hf-containing precursor and water into the a process chamber and repeating the process until a film with desired thickness is formed in paragraphs 0005 and 0042 et seq. This is performed in a reaction chamber 52 with a holder 80 that may be considered a tier substrate holder at least as broadly defined by the applicant, and the holder 80 holds substrates 82 that are less than 100 in number as shown in Figure 4. Purging the chamber in between pulses of the hafnium containing compound, or the first species, and the water, or the second species is described in paragraph 0021 lines 1-5. In paragraph 0058 et seq. the reaction chamber is held at a pressure of about 1 torr for the coating process. Doan et al. does not include a substrate temperature of 180 °C or purging conditions such as flow rate and purge time. Doan et al. teaches in paragraph 0024 et seq. that the temperature of ALD, pressure in

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the chamber and purging conditions vary with conditions of ALD such as particular precursors used, layer composition, deposition equipment and other factors. The variables of substrate temperature, pressure in the chamber, purging flow rate, and purge time therefore depend upon the conditions and apparatus employed in carrying out the invention. (see also paragraph 0022 et seq.) Their importance lies in impacting monolayer formation and the quality desired in the ALD layer. These variables are modified by routine experimentation, are result-effective, and thus are not inventive.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. by routine experimentation to include a substrate temperature of 180 °C, a purge gas flow rate of 100-10,000 sccm, and a purge gas flow time of 1-500 sec in order to form a film by ALD of a desired quality and monolayer formation absent evidence showing a criticality for the claimed ranges.

Claims 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of US Patent publication 2001/0054769 to Raaijmakers et al. Doan et al. is described above and includes flowing two reactive gases to form a film on a substrate by ALD. Doan et al. does not include flowing a carrier gas with the reactive gases. Raaijmakers et al. teaches using a carrier gas with the precursor and reactant gas in an ALD process in order to aid in the transportation of the precursor and reactant gases into the chamber (paragraphs 0079-0103 et seq.).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. to include a carrier gas with the precursor and reactant

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gas as taught by Raaijmakers et al. in order to aid in the transportation of the precursor and reactant gases into the chamber.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of Raaijmakers et al. as applied to claim 8 above, and further in view of US Patent publication 2003/0031793 to Chang et al. Doan et al. and Raaijmakers et al. include coating a substrate with pulses during an ALD process. Doan et al. and Raaijmakers et al. do not include a flow rate for the metal precursor or reactant gas. Chang et al. in paragraph 0041 teaches that parameters such as gas flow rate are influenced by the desired qualities in the deposited coating and hence the nature of the reactants. This variable is important to achieve a film with desired qualities. This variable is result effective and can be modified by routine experimentation and therefore is not inventive.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. and Raaijmakers et al. by routine experimentation to include gas flow rates in the range of 100-10,000 sccm in order to form a film by ALD of a desired quality and monolayer formation absent evidence showing a criticality for the claimed ranges.

Claims 22, 34-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of US Patent number 6607973 to Jeon. Doan et al. is described above and includes an HfO_2 film deposited on a substrate by ALD. Doan et al. does not include an interfacial layer between the substrate and the HfO_2 film. Jeon teaches that surface preparation in the way of an interfacial layer shown in Figures 1-3

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leaves a substrate terminated with hydroxyl groups in column 3 lines 23-29. One of ordinary skill in the art would recognize that having a surface terminated with hydroxyl groups would make the surface more reactive towards the Hf precursor gas.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Doan et al. to include an interfacial layer between the HfO_2 and the substrate as taught by Jeon in order to have a surface terminated with hydroxyl groups therefore having a surface more reactive towards the Hf precursor gas.

With regard to claims 34-36, Jeon discloses the thickness of the metal compound layer to be less than or equal to 50 Å.

With regard to claim 37, Jeon anneals the HfO_2 containing film to 300-900 °C in column 4 lines 55-60.

With regard to claim 38, Jeon deposits a film containing Si on top of the HfO_2 layer in Figures 5-7 that may be considered an electrode film.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of US patent number 6572705 to Suntola et al. Doan et al. includes the limitations to claim 24 as described above except for providing a substrate with a diameter greater than 195 mm. Suntola et al. teaches that ALD successfully deposits films on large substrates (e.g. 300 mm in diameter) in column 11 line 20 to improve process throughput.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. to include a substrate with a diameter greater than 195 mm as taught by Suntola et al. to improve process throughput.

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Claims 25-26, 52, and 79-80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of US Patent number 6818517 to Maes. Doan et al. is described above and includes an HfO_2 film deposited on a substrate by ALD. Doan et al. does not include specific lengths of time for the pulses of Hf containing precursor gas or the water vapor. Maes teaches that the Hf precursor gas is pulsed with 1.5 s and the water vapor is pulsed for 3.0 s in order to saturate the surface of the substrate in columns 4 and 5 lines 62-67 and 1-5, respectively.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. to include a the length of time to pulse the Hf precursor or the water within the range of 1-500 s as taught by Maes in order to saturate the surface of the substrate.

With regard to claim 52, Maes teaches heating the substrate under isothermal conditions in the abstract, lines 10-12.

With regard to claims 79-80, Doan et al. includes all of the provisions of claims 79 and 80 including the substrate temperature and pressure in the chamber that are result effective variables as determined above. Maes teaches an ALD sequence with Hf precursor, purging, and water vapor pulses that in total takes less than 30 seconds in columns 4 and 5 lines 62-67 and 1-5, respectively. Neither reference teaches the repetition of the sequence for less than 20 times. However, both Doan et al. and Maes teach that the ALD process should be repeated only until the layer achieves desired thickness (paragraph 0005 et seq. and column 4 lines 41-53, respectively) The variable of number of times the sequence is repeated depends therefore on the method

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employed and is important insofar as to determine desired thickness of the finished film. This variable is therefore result-effective and can be adjusted by routine experimentation, making it a non-inventive step.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. and Maes to include repeating the ALD sequence less than 20 times, the exact number by routine experimentation, in order to achieve a film of desired thickness absent any evidence for the required limit of 20 deposition cycles.

Claims 29 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of Maes as above, and further in view of Chang et al. The variables of gas flow rates are found to be result-effective as discussed above with regard to claim 9. It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. and Maes by routine experimentation to include gas flow rates in the range of 0.5-1 ccm or 100-2000 sccm in order to form a film by ALD of a desired quality and monolayer formation absent evidence showing a criticality for the claimed ranges.

Claims 59-60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of US patent publication 2002/0182320 to Leskela et al. Doan et al. is described above and includes an Hf containing precursor for a hafnium oxide film. Doan et al. does not include this film to be a hafnium alkylamide, $\text{Hf}(\text{NET}_2)_4$ or $\text{Hf}(\text{NEtMe})_4$. Leskela et al. teaches that the claimed precursors can be used to form an effective metal film by ALD in paragraphs 0092-0102 et seq.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. to include the claimed precursors as taught by Leskela et al. in order to produce the hafnium film by ALD with reasonable expectation of success and similar results.

Claims 61-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of Jeon as applied above and in further view of US Patent publication 2003/0049372 to Cook et al. Doan et al. and Jeon cover all the limitations of claims 61 and 62 except for a specific WIW uniformity. Cook et al. teaches that optimizing an ALD process by routine experimentation results in excellent WIW uniformity (see entire document) to ensure a high quality product.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. and Jeon by routine experimentation to optimize WIW uniformity in the ranges from 10-15% in order to ensure a high quality product, absent evidence showing a criticality for the claimed ranges.

Claim 78 rejected under 35 U.S.C. 103(a) as being unpatentable over Doan et al. in view of US Patent number 6946336 to Pange et al. Doan et al. is describe above and includes all the provisions of claim 78 expect for specifying a rate of deposition of 1 A per cycle. Pange et al. teaches an ALD technique for depositing metal oxide films with a deposition rate as low as 1 A per cycle to allow for a high degree of precision in layer growth (column 8 lines 8-37).

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It would have been obvious to one of ordinary skill in the art at the time of invention to modify Doan et al. to include the deposition rate as 1 A per cycle as taught by Pange et al. in order to allow for a high degree of precision in layer growth.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kelly Stouffer whose telephone number is (571) 272-2668. The examiner can normally be reached on Monday - Thursday 7:00-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Kelly Stouffer
Examiner
Art Unit 1762

kms



TIMOTHY MEES
SUPERVISORY PATENT EXAMINER